REPORT

OF THE

Health Department

OF THE

CITY OF CHICAGO,

ON THE

GERMICIDAL ACTION OF ZINCIC CHLORIDE

APRIL 16th, 1881.

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LABORATORY OF THE HEALTH DEPARTMENT,
CHICAGO, April 15, 1881.

OSCAR C. DEWOLF, A.M., M.D., Commissioner of Health:

Dear Sir—According to your instructions I have made a careful and critical examination of what is known as the "Germicide," an apparatus for the antiseption of water-closets. The term disinfection is now applied to such instances as the fumigation of houses after parties laboring under infectious diseases have been therein, whilst the word antiseption is used to denote the spoliation or the prevention of the putrefaction of house waste or other organic decompositions.

It has long been determined that the greatest danger to health is not to be apprehended from a swiftly and freely flowing current of sewage, but rather from stagnating, fecal, and other effete matters, prone to or undergoing decomposition.

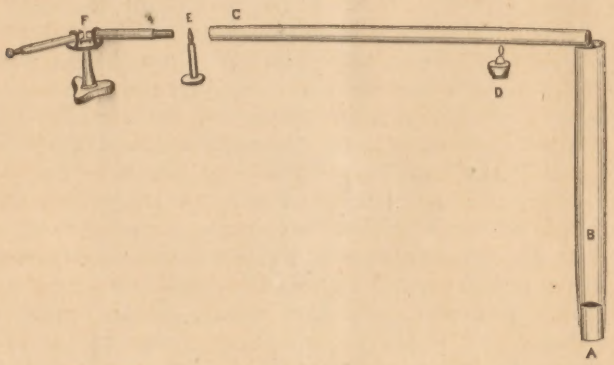
Professor Frankland, Chemist to the River Pollution Commissioners, London, demonstrated several years ago, before the Royal Society, how germs of infusorial life might be thrown off into the atmosphere by the bursting of bubbles of sewer-gas. This opinion had previously been held by others, but it was left to him to show practically. The result of his experiment on simply agitating the liquid was to "render it exceedingly improbable that the mere flow of foul liquid through sewers can impregnate the circumambient air with suspended particles." His next experiment is thus described: "A quantity of a strong solution of lithic chloride was placed in a shallow basin and acidulated with hydrochloric acid; fragments of white marble were then added, and a paper tube, five inches in diameter and five feet high, was placed vertically above the basin. So long as the effervescence continued, abundant particles of lithium were visible in a Bunsen flame held at the upper end of the tube. A tin-plate tube, three inches in diameter and twelve feet long, was now placed in such a position as to bring one of its open ends over the top of the paper tube. The tin tube was nearly horizontal, but slightly inclined upwards from the paper tube so as to cause a gentle draught of air to pass through it when it was slightly heated externally near its lower extremity. A bunsen flame placed at the end of this tube farthest away from the effervescing liquid showed that the suspended particles of solution of lithic chloride were not perceptibly less numerous than at the mouth of the paper tube; neither were they much diminished at the farther end of the tin tube when the height of the paper tube was increased to nine and a half feet. There can, I think, be little doubt that these particles which had thus been carried along by a gentle current of air for a distance of twenty-one feet, would be similarly conveyed to a much greater distance.

"The following conclusions as to the behavior of flowing sewage may be drawn from these experiments:

"1. The moderate agitation of a liquid does not cause the suspension of liquid particles capable of transport by the circumambient air, and therefore the flow of fresh sewage through a properly constructed sewer is not likely to be attended by the suspension of zymotic matters in the air of the sewer.

"2. The breaking of minute gas bubbles on the surface of a liquid, consequent upon the generation of gas within the body of the liquid, is a potent cause of the suspension of the transportable liquid particles in the surrounding air; and therefore, when, through the stagnation of sewage or constructive defects which allow of the detention of excrementitious matters for several days in the sewer, putrefaction sets in and causes the generation of gases, the suspension of zymotic matters in the air of the sewer is extremely likely to occur."—*Proceedings of Royal Society, February* 8, 1877.

I imitated Professor Frankland's experiment with the following apparatus:



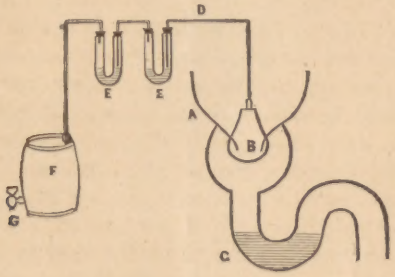
B is an upright tin tube, five feet high and five inches in diameter, open at the bottom end. C is a tin tube, twenty feet long and three inches in diameter, supported nearly horizontally from the edge of B, and heated for a short time by a spirit lamp (D), in order to establish a current of air through it. Into A (a beaker glass) were placed the lithic chloride, hydrochloric acid and marble, and by making use of the bunsen lamp (E) and spectroscope (F), I obtained the same results as Professor Frankland.

Now, if particles of lithic chloride of a decided specific gravity can thus easily be expelled from the beaker and caused to travel up a five-inch tube, and from its open end along a three-inch tube in an altogether different direction, by the slow effervescence of a little carbonic acid gas, how much more readily, he argues, might not the minute morbid bioplasm, or disease germ, be carried off into the at-

mosphere by the bursting of the large bubbles of sewer-gas? It must at all times be borne in mind that it is not necessary that a great deal of odor, if even any at all, must be given off in order to prove that sewer-gas is being evolved and probably finding its way into our dwellings or the open air. Neither has it yet been determined whether it is the sewer-gases alone, or the disease germs alone, or both together, which cause the many sicknesses we now attribute, probably a little freely, to "bad drainage."

Many years ago it was proven by direct experiment that the ordinary trap (S) filled with water was no preventive of the passage of sewer-gases into our homes. The gases are absorbed, or dissolved, as the case may be, at the lower end of the trap, and pass, by absorption or diffusion, to the inner end, where they may break away in the same manner as they first started from the sewage below, and pass into the air of the room. Their motion may also be expedited by evaporation from the surface of the water in the trap, or by the splashing of the water in opening the valve, as particles of salt are thrown into the air by the action of sea spray. If these gases are carrying germs of any kind with them they will be liberated into the atmosphere at the same time.

In order again to show that the gases pass through the water in the ordinary (S) trap of a water-closet, I fitted up the following aspiration apparatus:



A represents the pan of the water-closet, into which was fitted, air-tight, an inverted tin funnel (B). F is a vessel, at first filled with water, so that when the stop-cock (G) is opened and water allowed to trickle out, air must be drawn through the S trap (C), the funnel (B), the tubing (D), and the liquid in the U tubes (EE), in order to fill up the vacuum found in the upper portion of F.

When these U tubes are filled with solution of nitrate of lead, and the air from the sewer drawn through them, the presence of sulphuretted hydrogen will be shown by a brown-black precipitate appearing in the liquid. When they are filled with Nessler's reagent, and this air again drawn through, ammonia, if there, will show its presence by changing the liquid to a yellow-brown color, or throw down a bright-

red precipitate. In the experiments I have carried on, as you desired, I obtained decided evidence of the passage of these gases through the water of the S trap into the liquids in the U tube, although their odor, by the ordinary method, was not manifest.

With regard to the passage of germs through the water in S traps of water-closets, I made use of the apparatus, Fig. 2, as in the above experiments, only that I placed Cohn's fertilizing fluid in the U tube nearest the sewer, and Pasteur's fertilizing fluid in the other. These solutions are made up of such chemicals as will act as food for any germs which may be placed on, or enter, them. The materials were all chemically pure, as the intention was to make a microscopic examination of the solutions at the end of the experiments. This has been done, I believe, very fully by parties exceedingly competent to do so. In order that the apparatus might be as free from germ life as it was possible to make them, the India rubber and tin portions were very carefully cleansed with alcohol, and aspirated in a particular way in order to get rid of the last traces of alcohol. The rubber cords were soaked in alcohol and carefully dried, whilst the glass U tubes, the bent tubes, and the bottles in which the samples were taken for the microscopists, were rinsed with running water, with perfectly pure distilled water (that is as pure as I could make it by repeated fractional distillations in apparatus which I cleansed myself), and with alcohol, and then heated in hot air bath to a temperature of 380° F. Whilst they were cooling, care was taken, so far as possible, that only filtered air came in contact with them. The aspiration of the air from the trap was carried on for twenty-four hours, samples being taken out of the U tubes at the end of eight, sixteen and twenty-four hours respectively. So far as I could determine, numerous germs were to be seen in all the samples; the solutions were exceedingly cloudy; smelled sour, as though fermentation were going on; frothed, and became distinctly colored. These first experiments were all performed whilst the "Germicide" was detached from the closet; and no use of the closet was made during the time. During the period of the second course of experiments, the "Germicide" was placed in working order on the closet, and had only been in operation one hour and a half when the aspiration was commenced. The details of the cleansing of the apparatus and the procedure in conducting the experiments were exactly the same as in the first series, the results, however, being, so far as I could ascertain, materially different. All the chemicals, fertilizing solutions, etc., were tested and prepared by myself, and I was present all the time the experiments were going on. I also personally withdrew the samples and placed the first two in your hands and the other two in the hands of B. W. Thomas, Esq., President of the State Microscopical Society.

The use of the "Germicide" is to produce a constant stream of solution of chloride of zinc into the pan and trap of the closet, and an intermittent supply of thymol to the atmosphere of the room.

In my opinion zinc chloride will not only prevent the decomposition of fecal matters, but also render inoccuous those which have already decomposed. Chloride of Zinc is a *disinfectant*, not simply a deodorizer. It has the property of coagulating albumen. Now, as it has been agreed that all disease germs (or, as some prefer to call them, ferments) are albuminous and live upon albuminous food, we should say that the first property of chloride of zinc as a disinfectant lies in its either directly killing the disease germs by coagulation, or, indirectly, my making its food indigestible.

Its second property is its action upon such gases as ammonia, sulphuretted hydrogen, or ammonic sulphide forming with these, salts which are not liable to be thrown into the atmosphere, and one of which, ammonic chloride, is at least innocuous.

Its third property may be said to be made up of the first two, viz.: coagulating the albuminous substances, it renders them less easily decomposed into gases, and changing these gases into solid substances, the vehicle (these gases) for carrying bioplasms into the air cannot be supplied.

Fourth—Defective sewer pipes would not be so dangerous as they now are, as the constant supply of chloride of zinc afforded by this apparatus would give a quantity of this chemical wherever effete matters may have lodged.

I should now wish to describe the conditions of the second series of experiments—those using the "Germicide" and Pasteur's (this time nearest the sewer-pipe) fertilizing solution, and Cohn's fertilizing liquid, as they appeared to me. At the end of the first eight hours both solutions were yet clear, odorless, and having no frothing. At the end of sixteen hours Pasteur's solution was slightly turbid; whilst at the end of the twenty-four hours of the experiment, Pasteur's solution was turbid and Cohn's fluid remained still clear. In neither solution did I observe the unpleasant cheesy odor of the solutions in the first series (without the "Germicide"), nor yet that peculiar frothing, excepting slightly in Pasteur's after eighteen hours.

I should state that, between the taking of the eighteen and twenty-four hours' samples in this second series of experiments, the funnel B was removed from the pipes five times, and simply laid aside to allow of the legitimate use of the closet (thereby giving the antiseptic properties of zinc chloride a harder test), and aspiration again started without any attempt to cleanse the funnel specially after each use. Germs from the atmosphere may thus have found their way into the apparatus, and I should wish respectfully to call attention of the microscopists to this condition of affairs.

The object in using the $2\frac{1}{2}$ U tubes containing the different fertilizing solutions at the same time, was to show that the bubbling in the first one would throw the germs, if any were present, into the second.

Thymol, as I have already mentioned, is intermittently supplied to the air of the room by an ingeniously simple contrivance of closing and opening the lid of the water-closet. This, as is well known, is an exceedingly powerful ærial antiseptic, and has not the objections of carbolic acid, namely, its strong odor and acid properties.

On the whole, I desire to say that after eight days' constant and careful examination of the action of the "Germicide," I believe it to be singularly appropriately named and to perform all that is said of it, viz.: antiseption. I remain yours, very respectfully,

R. S. G. PATON, PH. D.,
Chemist of Health Department.

CHICAGO, April 15, 1881.

OSCAR C. DEWOLF, M. D., Commissioner of Health,
City of Chicago.

Dear Sir—Your note of Wednesday was handed to me by Dr. Paton, who also gave me six phials marked C, 1, 2, 3, and P 1, 2, 3, of which, in accordance with your request, assisted by C. S. Fellows, Esq., I have made a careful microscopical examination. The contents of all of these phials was swarming with life; but the organisms found in those marked C contained more of the larger forms than were found in those marked P. In C 1 we found Bacterium-termo, B. ulnea, B. lineola, spirillium, etc., and immense numbers of smaller organisms, hardly more than a point of light under a 1-12 immersion lens, with C oculars. C 2 was about the same as C 1, but in C 3 we found considerably more organic life. Phials P 1, 2, 3 contained nearly the same organisms as the above, but mostly of the smaller forms, and were much less numerous. Dr. Paton afterward gave me six other phials, marked respectively C 4, 5, 6, and P 4, 5, 6, which we examined with much care under a 1-15 Wales objective, showing many apparently dead organisms similar to those found in the first series of phials. In C 5 we found no living forms, but in all the others of this series we found a very few that gave evidence of life, and these can probably be accounted for by the exposure of the fluid to the warm and impure air of the room in which the examinations were made. T. D. Williams, M. D., assisted us in our examination of the last series of phials.

Very respectfully yours,
B. W. THOMAS.

HEALTH DEPARTMENT, APRIL 16, 1881.

To the Public: Some two weeks since Mr. E. J. Mallett, Jr., of New York, called my attention to an apparatus designed to supply a constant and uniform quantity of a solution of chloride of zinc to the water passing into the basin of the ordinary water-closet bowl. The results to be obtained by the presence of this mineral salt were said to be the entire antiseption of the water, and the destruction of all or-

ganic germs coming in contact with it from the sewer air in the pipe below and connected with the bowl.

I have never given the indorsement of my name to a single one of the many methods and systems designed to accomplish this purpose, and which have been brought to my attention during the past four years.

Mr. Mallett presented to me so many letters from medical gentlemen with whom I am acquainted in New York, commending him and his process, that I felt obliged to investigate his claim.

I therefore requested Dr. Paton, Chemist of the Health Department, and Mr. B. W. Thomas, President of the State Microscopical Society, to undertake the work. Their reports received this morning, and covering a week's labor, are of so much interest that I do not hesitate to give them to the public.

They emphasize the following fact, which is in a measure new to me, *i. e.*, the readiness with which organic germs pass through the water of a sewer-trap, and are thrown off from the free surface into the atmosphere of a room.

From the experiments detailed by Dr. Paton and Mr. Thomas, and many of which I witnessed, I must concur in their opinion that, as at present constructed and used, traps, however well supplied with water, can only act as a very temporary obstruction to the passage of disease germs into our homes from the sewers with which they are connected; and again, that it is entirely practicable to render the water in these traps so perfectly aseptic as to destroy disease-bearing germs that come in contact with it. I commend the system of Mr. Mallett as practical, economical and scientific, and believe that if it were generally introduced into the homes of our city it would protect each household so connected from many of the dangers of sewer-gas, and would also render the air in our sewers aseptic and pure.

OSCAR C. DE WOLF, M. D.,
Commissioner of Health.